UNIVERSITY OF TEXAS AT DALLAS - DEPARTMENT OF PHYSICS

PHYSICS COLLOQUIUM

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Spectroscopy of Carbon Nanotubes: How Useful is It?

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Spectroscopy, both absorption and emission, is a powerful tool to examine single-wall carbon nanotubes. I will discuss three applications of the spectroscopy techniques for nanotube analysis. First: precise purity measurements of carbon nanotube samples. This technique is based on separation of contributions from nanotubes and impurities to the near-infrared absorption, and measures purity relative to a standard sample. A reference standard for NIR measurements was developed based on TGA, TEM and Raman observations. It was used to determine relative contributions of nanotubes and impurities to NIR absorption in π-plasmon background and Van-Hove peak areas, and calculate nanotube/carbonaceous impurity ratios in various samples. Second: an extension of this technique to determine the metallic-to-semiconducting ratio in nanotube samples. This has become an urgent need since Nanomaterials group at Johnson Space Center teamed up with Rice University to produce samples enriched in metallic nanotubes by pulsed laser vaporization technique. So far, nanotube type distributions were determined by state-of-the-art electron beam diffraction measurements, and we demonstrated up to 18% armchair metallic nanotubes. E-beam diffraction is extremely difficult and time-consuming, but can be used to calibrate extinction coefficients of metallic and semiconducting nanotubes and measure their ratios by absorption spectroscopy. Third: unique measurements of emission spectra of individual nanotubes, and their dependence on the uniaxial strain applied to nanotubes. While similar measurements of Raman and emission spectra were reported on collections of nanotubes, this is the first time such experiments are possible on unambiguously identified individual nanotubes. The measurements agree well with theory and allow to measure carbon-carbon transfer integral experimentally.

About the speaker: Dr. Pavel Nikolaev received his B.S. and M.S. in physics from the Moscow Institute of Physics and Technology in 1993, where he studied high-temperature superconductivity. That was followed by Ph.D in physics from Rice University in Houston, TX in 1998, where he worked on carbon nanotube production techniques. He is currently a scientist at ERC Inc. and works at NASA Johnson Space Center, Houston, TX. His interests encompass production, processing, characterization and applications of carbon nanotubes. He was the Welch Foundation Predoctorate Fellow (1994 – 1998) and received NASA GEM ("going extra mile") award in 2004.